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JACOB T. HUNT, *Editor*

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Today's Challenge in Science

ARTHUR ROE
Chairman, Department of Chemistry, University of North Carolina

ONE HUNDRED YEARS ago we did not have radio, television, automobiles, radar, sulphanilamide, antibiotics, quick-drying paints and varnishes, plywood, aluminum, synthetic rubber, nylon and a host of other synthetic fabrics, airplanes, and vitamin-enriched foods; neither did we have poison gases, tanks, atomic submarines, and atomic bombs. The development of these—some good and some questionable—has been brought about for the most part by scientists working in the industrial and academic laboratories of this and other countries. Fifty years from now, if the present pace continues, a new host of presently undreamed-of wonders will exist and will make our lives, we hope, fuller and richer.

As science and technology increase in importance in our everyday lives, it is obvious that the number of scientists and technologists must also increase if we are to keep the pace. It is undeniable that at the moment there is a great shortage of trained scientists and teachers of science in this country; quite alarming is the fact that there are not enough students now entering upon scientific careers to meet the ever-increasing demand. For example, one company has said that it would like to hire all the people receiving the Ph.D. in mathematics in the United States this year. In chemistry and chemical engineering, just five of the largest chemical companies in the country have stated that they wish to hire now about 1,350 Ph.D.'s; this is approximately the total number of Ph.D. degrees that will be granted by the universities of this country this year in these fields.

Never has the opportunity been so great nor the prospect so bright for students who wish to enter a scientific career; never has the obligation been so heavy on us in Education to offer adequate preparation in the sciences and mathematics, and to make the opportunities in science well enough known and the training in science interesting enough to attract the large number of students that will be needed to maintain our scientific progress.

For those who are inclined to enter a teaching career, there will be abundant opportunities both in the elementary schools and in the secondary schools; large numbers of new teachers will also be

needed in the colleges and the universities to cope adequately with the avalanche of students now inexorably marching through our educational system. Salaries and teaching conditions for teachers in the secondary schools are not always the best, but it seems certain that improvement must be made in the near future, and the teaching profession can certainly look forward to better salaries and better teaching conditions before many years have past. At the university level there are now many teaching positions open in excellent colleges and universities, and this situation is sure to continue for many years.

The training given to prospective scientists in the schools is obviously of the greatest importance. Competence in the English language and a thorough background in the social sciences and the humanities is, of course, essential. Over and above this, however, the student must have sound mathematical preparation; adequate courses in algebra, geometry, and trigonometry should be given in the secondary schools. It is also highly desirable that the prospective scientists receive some science training in the elementary and secondary schools. It is my opinion, however, that it is better for a student to receive no training at all in a science at this level than to receive poor training. At the present time there are not nearly enough qualified teachers of science in the elementary and secondary schools, and as a result many science courses are being taught by teachers who are not thoroughly grounded in science, and who are probably not particularly enthusiastic about teaching these courses anyhow. We have in the schools a great opportunity for kindling enthusiasm for science; I fear that often we are killing rather than kindling enthusiasm by exposing students to a poorly taught course in chemistry, physics, or biology in the early stages of their training. I was launched on my chemical career by a high school teacher whose enthusiasm for chemistry was boundless; in addition to being an excellent teacher, he was carrying out a research program in his laboratory having to do with the determination of fluorine in water. He would let his students help him with some of his research work, and this glimpse of chemistry and chemical research was so intriguing that I determined then and there to be a chemist. I am sure this example can be multiplied many many times over. On the other hand, I recently talked to a boy who had a most unfortunate experience in the other direction; the teacher in charge of his chemistry class was an English teacher who had had one course in chemistry some twenty years ago, and who was drafted into science teaching more or less against her will. The chemistry course was

so poorly taught that the boy vowed never again to set foot inside a science class if he could help it.

At the college level, a prospective scientist should take care to receive a thorough educational background in mathematics, English, a foreign language, the social sciences, and the humanities, and should also attempt to take courses in two or three sciences other than the one in which he is specializing. Many students who wish to major in science in college find themselves at a disadvantage because they did not take sufficient mathematics in high school; this point cannot be emphasized too strongly. Many opportunities in industry and in teaching are opened to the scientists with an A.B. or a B.S. degree; further opportunities await those who decide to go on to a Master's or to a Doctor's degree.

Today's challenge in science is a three-fold challenge. It is first of all a challenge to the entire nation to realize that its future progress, safety, and perhaps even its very existence depend upon its ability to train an increasing number of competent men and women in science. The nation must realize that good teachers from the elementary schools through the universities are needed and that it must pay whatever is necessary to provide them. There is also a challenge to those of us who are now in science teaching; we must bend every effort to attract the ablest and best students to careers in science. We must do this by giving courses in the sciences that are at the same time adequate, thorough, and well presented. And last but not least, there is a challenge to the youth of our nation today to undertake the study of science, and to undertake a career in science in teaching, in industry, or in research. The last geographical frontiers in this country have long since vanished, but new frontiers in science are appearing every day, and an exploration into these unknowns of science is one of the most exciting and thrilling of experiences.

Activities of the Oak Ridge Institute of Nuclear Studies

DEWEY E. LARGE

Head, Special Services Branch, American Museum of Atomic Energy, The Oak Ridge Institute of Nuclear Studies

THE Oak Ridge Institute of Nuclear Studies is a unique educational organization in that it is a corporation owned by thirty-four universities in fourteen Southern and Southeastern states, the District of Columbia, and Puerto Rico.

The Institute, a nonprofit organization which was incorporated in 1946 and established at Oak Ridge, Tennessee, operates under direct contract with the United States Atomic Energy Commission. The majority of its programs are for the southern part of the United States, but many are nationwide and a few are of international scope. Several of these programs are those which the Institute has petitioned the Atomic Energy Commission to carry out in behalf of universities, and the others are activities which the Commission called on it to carry out in behalf of the Atomic Energy Commission.

Educational in nature, the Institute's activities are diverse, and are conducted by its four principal divisions. These divisions are the University Relations Division, the Special Training Division, the Medical Division, and the Museum Division.

The University Relations Division is concerned with those activities which are of direct interest to the Institute's member universities and to other universities, both in the geographical area served by the Oak Ridge Institute of Nuclear Studies and in other parts of the United States. A research-participation program enables university faculty members to spend varying periods of time (usually the three summer months) conducting research in Oak Ridge laboratories. This research provides the atomic-energy program with new ideas and the universities with current information and fresh viewpoints in nuclear science. An Oak Ridge graduate fellowship program is administered by this division to make possible opportunities for candidates for the master's and doctor's degrees in the sciences to work and study in the extensive laboratory facilities of Oak Ridge. Regular course work and other requirements for graduation are met at the university which awards the degree upon satisfactory completion of research.

Arrangements are made through a traveling lecture program for lecturers from the Oak Ridge scientific staff (primarily Oak Ridge National Laboratory) to conduct seminars, and to take part in other scientific activities on university campuses. The Institute and the Oak Ridge National Laboratory jointly sponsor summer, regional, and special symposia in fields related to the atomic-energy program. Summer symposia have been held in Oak Ridge. Regional and special symposia have been held at several universities in the South.

In addition to these activities, the University Relations Division administers special United States Atomic Energy Commission fellowships in radiological physics and in industrial hygiene. The special fellowships lead to the master's degree at designated universities, and students in radiological physics also receive field training at an Atomic Energy Commission installation.

In the area of local education, this division operates a subcontract with the University of Tennessee in nearby Knoxville, enabling Oak Ridge workers to continue their formal educations by attending graduate courses at night and on Saturdays.

The Special Training Division of the Institute was established to train mature scientists in the techniques of using radioactive isotopes and other special tools which have come into the field of science as a result of developments in nuclear science. This division has trained more than 2,300 scientists from throughout the United States, Puerto Rico, and many foreign countries in the safe and efficient use of radioactive isotopes. Courses of four weeks' duration in the basic techniques of using radioactive isotopes are offered. As part of the "atoms for peace" program, two such courses have been presented exclusively for scientists from foreign countries.

Courses which are two weeks in length are conducted regularly, primarily for United States military veterinary officers. Other special and advanced courses, of one to four weeks' duration, are offered according to need and demand. Secondary-school science teachers from throughout the United States have participated in summer science institutes conducted by this division. It is expected that this activity for precollege teachers will be continued with the aid of the National Science Foundation.

The Medical Division of the Institute came into being as a result of a request by the United States Atomic Energy Commission that the Oak Ridge Institute of Nuclear Studies undertake a study to determine the value of radioactive materials in medical diagnosis and therapy. This division, which operates a medical research

hospital, is conducting fundamental and applied studies of the value of internally administered radioactive isotopes, and of external radiation beams directed intensely into the body from machines using a strong source of high radioactivity.

The Museum Division of the Institute operates the American Museum of Atomic Energy in Oak Ridge, the only one of its kind in the world, where more than 500,000 persons have been instructed in the production and use of atomic energy through demonstrations, scale models, motion pictures, and other devices illustrating the principles of nuclear-science processes. More than a million persons a year learn about atomic energy through circulating exhibits consisting of large exhibits, package-type exhibits, and secondary-school demonstrations sent throughout the United States.

This division disseminates information of a nontechnical nature and serves all levels of education. Its programs are concentrated in the South and Southeast. Their scope, however, is nationwide.

The Oak Ridge Institute of Nuclear Studies science fair program is carried out under the auspices of the Museum Division. This program was activated in June of 1954 to help alleviate a serious condition which exists in the United States today: the demand for scientifically trained personnel has increased tremendously and is continuing to increase while the percentage of young people embarking on scientific careers is decreasing. Since this situation presented and still presents an alarming problem, the Institute's Board of Directors authorized the science-fair program as a means of establishing and developing science fairs and related activities in the belief that such activities would be of great value in stimulating interest in science on the part of students and teachers. Prior to this time, the Institute had been concerned specifically with research and the dissimination of information directly related to nuclear science, but this program is designed to encourage investigaton, participation, and learning in all the sciences.

Organizing and executing a science fair entails more than agreeing that it is good and should be held. A successful science fair requires much planning and work. The Museum Division of the Oak Ridge Institute of Nuclear Studies is charged specifically with the responsibility of assisting in establishing and improving science fairs as means of expanding and extending science education throughout fourteen southern states and Puerto Rico. The approach has been made through work conferences designed to give inspiration and instruction in the total aspects of science fair activity. These conferences are held on the campuses of institutions of higher

learning and in cooperation with state academies of science, state departments of education, science teachers' organizations, professional scientific organizations, civic clubs, industries, and institutions of higher learning. Fourteen such conferences have been arranged and executed in which instruction has been given to more than 1,400 conferees consisting of precollege teachers, instructional supervisors, educational administrators, and representatives from colleges and universities, industry, and the communication media. These conferences have been of three distinct classifications according to geographic scope: regional, designed for three or more states; state, giving special coverage within the boundaries of one state; and district, involving conferees from several counties or school systems within a state. The National Science Teachers Association and Science Clubs of America have participated in several of the conference programs.

A representative from this division has had program assignments concerning science fair activity at six meetings of state academies of science and at several meetings of professional educators on district, state, regional, and national levels.

Follow-up assistance is given by arranging for any person who is interested in project teaching and science fairs to receive instructional aids free of charge.

In 1955, 119 new science fairs were recorded following the work conferences; thirteen of these were represented at the National Science Fair. Indications are that there will be 400 more new fairs during the 1955-56 academic year. Three state science fair work conferences for 1956 are now in the planning stages and more are anticipated.

In addition to the circulating-exhibits program and the science fair program, the Museum Division carries education to the public through educational television programs, and teacher pre-service and in-service training, working with teacher groups and accredited teacher-training institutions. Service is given in the areas of development of science museums and junior academies of science.

The Oak Ridge Institute of Nuclear Studies, through its varied educational programs, has taken definite steps toward meeting the challenge of developing and establishing educational activities to meet the needs and interests of everybody.

The National Science Fair: Purposes and Program

JOSEPH H. KRAUS
Coordinator, National Science Fair, Science Clubs of America

THE National Science Fair is the nation's annual spectacular showpiece of the best science exhibits made by individual students attending school in grades 10, 11, and 12. These exhibits from local science fairs are brought together each year for a grand demonstration of what boys and girls are doing in science. The efforts of many different groups will climax when the Seventh National Science Fair is held May 10-12, 1956, in Oklahoma City.

To the student who has been selected to exhibit his masterpiece, the NSF represents national recognition for accomplishments far beyond the required school curriculum. It may be that a hobby which intrigued him is at long last recognized for some of the qualities of which he always was cognizant. To the high school educator, the NSF becomes a tribute to the inspiration and guidance previously given to the student. To elementary school teachers the NSF proves that scientists are started along the lines of their future success at very early ages, sometimes even before they enter kindergarten. Thus there is full participation for an early indoctrination of students into the background for science.

To the committee charged with the responsibility for running the regional or state fairs, which are affiliated through contract with the NSF, it fortifies one American tradition that anything can be accomplished when a sufficient number of dedicated leaders join to solve a major problem.

To universities, colleges, and other institutions of higher learning tied closely to the regional or local fair, the NSF becomes a motivating tool. Simultaneously the regional or state fair provides a common ground on which educators and scientists can meet to discuss and plan programs calculated to best supply the scientific and technical leadership for tomorrow.

PURPOSES AND PROGRAM OF THE NSF

The NSF is dedicated to inspiring greater interest among students in the fields of pure and applied science. By bringing together the students who were declared best at their respective

regional and state science fairs, the national event lets them see for themselves how their work compares with the performance of others. Each finalist is the banner-bearer for from 32 to 2,500 other students who competed with him at the local science fair. Thus each has a real responsibility.

The fair directors, educators, and newsmen who accompany the students find that the NSF gives them an opportunity to compare notes, see what others have done, resolve problems, and annually help toward the improvement not only of their own efforts, but also of the NSF itself.

Each finalist is awarded a solid silver medal with its solid gold science emblem, engraved with his name and that of the sponsoring organization. The school which he attends is given a certificate with a facsimile of this medal. In addition, each finalist has a chance to share in the now famous "Wish Awards"—scientific material, equipment, apparatus, books, etc., freely selected by the student to further his scientific education.

But these awards are merely extra topping on an already rich cake. The fact that the finalist was selected is the biggest honor. This stays with the student for the rest of his life.

At the NSF the finalists are treated to a round of meetings with world famous scientists. The students visit scientists in their laboratories or research centers. They dine with each other. The boys and girls explain their projects to scientists in technical terms and to the public in language which it can understand also. The students and their escorts see industry and its many facets of applied science, research, and testing. Famous judges, each a recognized authority in a specialized field of science, evaluate the exhibits and interview some of the finalists.

In this entire program the emphasis is not on what the student knows now, but what he might do to elevate his sights. He is encouraged to drive forward with greater determination, to view his work, and that of all others, with an open mind and discerning eye, then come to his own conclusions about what he hopes to make his life's work. And those he meets stand ready to help him.

QUESTIONS AND ANSWERS

It might be proper at this time to pose some questions and supply answers from the evidence.

How much motivation does a science fair give to the young student who, because of age, has no opportunity now to aspire to national recognition? Tabulation of data obtained from question-

naires sent to NSF finalists discloses that most of these students were launched on their scientific bents before they reached high school. The great majority first became interested between the ages of 8 to 11. One girl won top honors at local and state fairs for 8 years. Many try for honors again and again. Increasing numbers show up two or even the maximum of three times as finalists, and also appear more frequently at the Science Talent Search for the Westinghouse Scholarships, also conducted by Science Service through its Science Clubs of America.

How much influence does the NSF have toward elevating the sights of students who are selected as national representatives? Most finalists had a very definite idea of what they hoped to become in the future; 72 of the 110 reporting (from a total of 136) declared that their views remained the same after they participated in the NSF; 27 intensified their intent to drive forward; 11 scaled upward their future goals thus: from dentistry to medicine, from mechanical engineering to research physicist, from a college career to medical research, from no particular interest to parasitologist, etc.

Does the enthusiasm of one finalist infect others? How much of it filters back to his home area? Most of the finalists are honored in school assemblies after they are designated to go to the NSF. They again are singled out at the time the NSF school award is presented. Those who return to classes after the national event are asked to recount their experiences at a school assembly, science club, or Academy of Science. A few tell the story in many towns. At least one has told it in many states and throughout her own state. In addition to their appearances on the CBS coast to coast program, "Adventures in Science" with Watson Davis, Director, more than a third of the finalists have appeared on radio or television programs. One appeared on TV a total of 9 times and once on radio; one made 5 appearances on radio and once on TV; 6 finalists filled a program on one TV station. And in addition to the above, two TV channel shows and 35 radio and TV stations carried the events to the viewing and listening audience this year.

How much recognition can the NSF give to public and high school teachers who may be required to give more time and effort to this extra curricular effort? The public acclaim which educators get through their regional science fairs is modest by comparison with the sincere affection with which finalists continue to remember them; 36.7 percent of them list their teachers as being directly responsible for arousing their first interests in science, and credit them for motivating and helping them toward the future success they

hope to have. The second largest influence, 23.4 percent, is the home.

How successful has been the NSF in focusing the attention of universities, colleges, and schools of technology upon the science fair movement? At least 200 institutions of higher learning are either closely associated with their local fairs or are directly responsible for catalyzing their fairs. Of course, elementary and high school teachers comprise the working committees.

What is the reaction of these institutions of higher education to the science fair movement? Speaking on the "Value of Science Fairs in Education" at the West Virginia Science Fair Work Conference, in November, 1955, Dr. Ashby C. Blackwell of the West Virginia Academy of Science and Dean of the Faculty of Morris Harvey College, said on November 1, 1955: As a representative of higher education, I cannot resist the urge to express what I believe is our concept of the value of science fairs in education. It is my belief that the science fair is an educational tool of tremendous significance, for

(1) it motivates the exhibitor to strive for greater achievement;
(2) it challenges other students and inspires them to prepare exhibits;
(3) it gives the parent a special opportunity to gain a greater appreciation of the advantages of education; and
(4) it links the college and the university very closely with the student through the assistance which is given to the student in preparing the exhibit and through the assistance which is given to the institution of higher learning in discovering talent which it should share in developing.

How do newspapers feel about giving financial and/or other support to science fairs? Nearly all newspapers which sponsor or co-sponsor their regional science fairs are giving greater recognition to them year after year. The *Kansas City Star,* for example, devoted an entire color-roto section to its science fair and the NSF. Most newspapers devote more column inches to their science fair programs than to any one other activity. Newspapers supporting science fairs show the same high degree of dedication and high purpose which is so evident among educators. In not a single instance to date have they told the educators what to do or how to do it.

What is the reaction of scientific, civic, and technical societies? How does industry feel about the local and national fairs? Nearly every organization is listed among the galaxy of scientific, technical, and civic societies which help sponsor science fairs. The Washington, D. C., Fair has now expanded to become four fairs, all sponsored

by the Washington Academy of Sciences and its affiliated societies, the District Council of Architectural and Engineering Societies, the D. C. Board of Education, and the Boards of Education of the adjacent counties. The San Francisco Fair numbers about 100 co-sponsors, including all institutions of higher learning, educational systems in the area, industries, and about 75 newspapers. The Spokane, Washington, fair boasts of 67 co-sponsors. In some areas the medical societies finance the entire program; in many it is the university or college; in three it is the Kiwanis Club; in one it is a state bank and national bank. The American Chemical Society appears in many places as one of the co-operating organizations in the regional fairs.

What is the reaction of the public to the local science fairs? The regional science fair is a striking show to which flock most parents and relatives of the exhibitors, and many of their friends. One city reports that more than 16 percent of the entire population of the area attended the fair; another claims 30,000 visitors; a third declares 150,000, but this fair also is part of another exhibition. At every level, whether it is a classroom fair or a regional operation, a properly publicized fair will bring out the crowds. A large regional fair will be visited by bus loads of school pupils. This is true of the NSF also.

How do finalists feel about the NSF? When students strive for NSF honors two or more times, it would seem to indicate that they like the rewards. Pages could be filled with the superlatives not only mailed in after the NSF is over, but sent as greetings to those finalists who come to the national event many years later. This feeling seems to be shared by the educators and newsmen who accompany the finalists to the NSF, by the scientists who talk with the students about their exhibits and their future hopes and aspirations, and also by the industrial leaders whose plants and laboratories are visited.

Give American youth a challenge and it will rise to the occasion. Set a mark at which to shoot and American youth will strive to best that mark. Educators can see these results at a science fair in a matter of months. Any photographic comparison will furnish evidences of annual improvement, better exhibits, and more intensive extra-curricular effort year after year.

For action, drama, competition, excitement, and thrill, a science fair offers as much as any sporting or other event.

North Carolina Science Fairs and the North Carolina Academy of Science

JOHN A. YARBROUGH
Secretary-Treasurer, North Carolina Academy of Science, Meredith College, Raleigh

THE North Carolina Academy of Science, organized in 1902, has sought to promote scientific study and research in the state through annual meetings for scientific reports, publications, work in conservation and legislation, and work with young science students. Its members have been scientists, teachers of science at all levels, and other persons interested in science. The Academy has, for many years, shown a special interest in science instruction at the secondary school level. It has also been concerned with the encouragement of science talent through competitive exhibits held in conjunction with the annual Academy meetings. Essay contests for high school students have been sponsored by the Academy with the help of certain other groups. These activities did not, however, touch a large number of students, and, in the opinion of many, were not adequate in the light of present day needs for the recruitment of young scientists.

Thus in 1954-55 the Academy launched a much enlarged program involving six district science fairs, using the established N.C.E.A. district, and a state fair in which winners from the districts competed for state honors. Approximately 800 exhibits were presented in the six district fairs from which 60 were chosen for the state science fair. Winners in the physical science division and their exhibits were:

First place—Charles Canada, Guilford High School, "Automatic Light Control"

Second place—William Montgomery, Myers Park Junior High School, "Indicating Geigerscope"

Third place—Harriet Suzanne Cameron, Hoke County High School, "Rock and Mineral Collection"

Winners in the biological science division and their exhibits were:

First place—Leonidas Betts, Fuquay Springs High School, "Archeology in North Carolina"

Second place—Charles Egerton, Durham High School, "Anatomy and Histology of the Cat"

Honorable Mention—Betty Lou Wallace, Mt. Park High School, "Steps in Entomology"; Peggy Lennon, Greensboro High School, "Bacteriology"; Robert L. Smith, Albemarle High School, "Photosynthesis: The Action and Related Factors"

Prizes of $50, $30, and $20 were given winners in the physical science division by Cardinal Products Incorporated of Durham and prizes of $25 and $15 to the winners in biological science by Carolina Biological Supply Company of Elon College.

Though not planned in the beginning, it became possible after the state fair to send first place winners in each division to the National Science Fair at Cleveland, Ohio, on May 12-14. Each of these students won a fourth place award in national competition indicating his position in the upper twenty-five percent of the National Fair entries. As a result of the district and state fair program developed by the Academy, a considerable increase was noted in the number of local fairs held in the state and in the interest exhibited at these fairs. Some high schools or communities have been holding science fairs in past years but without the incentive of the wider competition offered by the district and state fairs.

Colleges and universities played vital roles in the new program by acting as hosts and offering facilities for displaying science exhibits. Duke University was host to the State Science Fair. District fairs were held at East Carolina College, Flora Macdonald College, North Carolina State College, Woman's College of the University of North Carolina, Catawba College, and Western Carolina College. A division of the western district of the state was effected this summer with the result that Appalachian State Teachers College and Western Carolina College will both sponsor district fairs in 1956. Other changes in hosts for the current year are shown in the 1956 schedule at the end of this article. To the splendid cooperation of all these colleges and to the diligent work of the fair directors must go much of the praise for the success of the Academy's program. The planning and operation of the fairs has been in the hands of an Academy committee headed by Dr. Hollis J. Rogers of the Woman's College of the University of North Carolina.

For the instruction of high school teachers in the science fair program and to the end of sponsoring a larger number of local fairs, two work conferences were held in our state within the past sixteen months. These conferences were made possible by the generous support of the Oak Ridge Institute of Nuclear Studies and the two host institutions, the University of North Carolina and A. and T. College. Competent science fair leaders from North Carolina and other states were available at both conferences which were well attended by high school teachers and members of college staffs.

Essay contests have been held on both district and state levels in three subject areas, forestry, ornithology, and wildlife. Sponsorship for the essay contests including choice of subject and presentation of awards, has been in the hands of the North Carolina Forestry Association for forestry and the North Carolina Wildlife Federation for wildlife. The essay contests for ornithology are sponsored by a number of the state's local bird clubs and by interested individuals.

A survey of the results of science fairs and essay contests conducted in North Carolina in 1954-55 by the Academy provides a realistic basis of hope for the success of the 1955-56 program. There is indication of increased interest from high school teachers and students as well as genuine concern for strengthening and broadening the program on the part of affiliated and sponsoring organizations. More attractive opportunities and awards for a larger number of young scientists will be available this year.

Certain fundamental principles and concepts which appear to be important and which will guide future planning of the Academy follow.

In the opinion of many, the local fair is more important than one at any other level. Certainly an excellent fair project must arise in some specific high school in the mind of some local boy or girl and under the guidance of some interested and competent teacher. The competitive exhibit at the home school where parents, friends, and local citizens may view the outcome of the student's work is the first step and probably the most valuable one in the program of fairs sponsored by the Academy. The Academy will have available for next year several sets of color slides showing various types of exhibits, both good and bad, exhibited this season in the fairs. These slides should help both teachers and students in planning exhibits for their own local fairs. Much helpful written material will be available from Science Service in Washington, D. C., and from the Atomic Energy Museum in Oak Ridge, Tenn. The Academy, working with other agencies, will strive to promote wider use of the local fair as a means of encouraging young students to express their interests in all fields of science.

The local fair should certainly include both senior and junior high school grades competing, probably, in different divisions. The inclusion of intermediate grades in a local fair will depend on the interest of local teachers. It is desirable, if such teachers are cooperative. On the basis of present plans, the Academy's district

fairs will serve only senior and junior high school students, competing in separate divisions. The state fair will include only senior high school exhibits since only these—tenth, eleventh, and twelfth grade students—are eligible for national competition.

An attractive certificate of participation will be presented to all who exhibit at the district fairs. This award, modest as it is, certifies a real achievement and is actually held in high esteem by the young scientist. An award of merit will be added for all who qualify for the state fair. In this manner the diligent work of all exhibitors will be recognized. All are winners, in the sense that awards are presented, but even more truly in the sense that development of the individual has occurred.

Monetary awards will be offered in the state fair and the Academy has arranged some awards in the district fairs. Development of further awards on the district level will depend upon the interest and initiative of the fair director and other individuals and organizations in the area.

A great stimulus for high achievement is produced by the possibility of exhibiting at the National Science Fair. It is the purpose of the Academy Committee to seek affiliation of our state fair with the National Fair on a permanent basis. As interest and support for the district fairs develop, it is possible for each to become affiliated with the National Fair and to send two students to the national competition.

Because they offer the opportunity to stress scientific writing, it is hoped that the essay contests may be strengthened both in number of participants and in quality of work done by the students. This type of activity can be wisely used to teach careful reading of scientific material, bibliographic skills, and good English composition—all valuable in the training of scientists. The Academy plans to continue and improve the essay contests.

As these plans unfold in the future, it is the hope of the Academy Committee that more responsibility for their operation will be assumed by high school teachers and even by the students. Development of leaders in the actual field of action will strengthen the program. The Academy, through its committee, will still play an important role but it is desirable that leadership develop on the high school scene proper. Only thus can the full potential of science talent, teamed with leadership, develop among our future citizens. If high school teachers of science are to assume their full role in this development it is obvious that their membership in the

Academy will be required. Only thus can they participate fully in making and executing the necessary basic plans. The Academy can function as a potent force in promoting science education but must be actively supported by all science groups and science teachers in particular.

The North Carolina Academy of Science recognizes the need for encouragement of science talent at another educational level—the college undergraduate. To help in this group it sponsors a Collegiate Academy, meeting annually with the Senior Academy and operated by student officers with the help of an advisory committee. Students report on research projects and maintain a small journal, *Cancas,* for publication of their best papers and news notes of the college groups. Thus an attempt is made to continue the encouragement of an interest in science projects which in the college years take the form of scientific research. This complete program—from intermediate grades through college—is the answer of the North Carolina Academy of Science to the pressing problem of recruitment of scientific manpower.

The locations, dates, and directors of the North Carolina district and state fairs for 1956 follow:

DISTRICT FAIRS

Northeastern, East Carolina College, Greenville, April 6; J. O. Derrick

North Central, Duke University, Durham, April 7; T. D. Reynolds

Southeastern, Wilmington College, Wilmington, April 7; J. D. Charlton

North Piedmont, Woman's College, U.N.C., Greensboro, April 7; Victor M. Cutter

South Piedmont, Davidson College, Davidson, April 7; H. E. Fulcher

Northwestern, Appalachian State Teachers College, Boone, March 31; Ray Derrick

Western, Western Carolina College, Cullowhee, April 6; J. G. Eller

(Entry blanks, available from the director, must be in his hands *at least seven days* before the district fair.)

STATE SCIENCE FAIR

University of North Carolina, Chapel Hill, April 20, 21; Victor A. Greulach

Our First Science Fair: Problems, Pitfalls, and Satisfactions

DUNCAN B. LEWIS AND MARGARET E. COPELAND
East Durham Junior High School, Durham, North Carolina

MANY PROBLEMS were encountered in organizing our first science fair last spring, but perhaps the greatest problem was lack of student motivation. How could we get our students interested? Since few students or teachers had ever seen a science fair it was necessary first to explain the purpose and the possible types of projects. These included research, imagination, duplication projects, and projects that illustrate some scientific principle. Then the ideas which we had originated plus those which we had collected from our studies of fairs presented by other schools were illustrated with pictures and actual exhibits. For other suggestions the children searched through science project books that we had been collecting for several years. Our librarian was of great help and set aside a complete shelf of pertinent books. Among the most useful books we had were Volumes I-VII of *Science Teaching Today,* published by the National Science Teachers' Association; *After Dinner Science* by Kenneth M. Swezey; *The Science Teacher,* journal of the National Science Teachers' Association; and Volumes I-II of *The General Science Handbook,* published by the Bureau of Secondary Curriculum Development, New York State Education Department. Although the children were encouraged to use these books only to stimulate ideas for other exhibits, there were a great many "cookbook" projects tempered by a questionable amount of research.

In order to stimulate further interest and to give added motivation, we promised to give an exhibitor's button to each entrant and certificates and ribbons to the winners in each division.

Lack of motivation should not be such a problem for this year's fair since all of the ninth grade students have made projects in the past and the majority of the eighth grade students have had some experience in constructing group projects. We have also been fortunate in securing from Mr. Dewey Large, coordinator of the science fair program of the Oak Ridge Institute of Nuclear Studies, slides of the Washington, D. C., Science Fair and the Kansas City, Missouri, Science Fair. These were shown with comments given

as to the different types of projects that could be made and as to what the judges would look for in winning exhibits. We have since ordered a set of *Student and Teacher Science Fair Handbook* for each science teacher in the school.

Perhaps the most annoying problem, and one that remains still unsolved, was lack of working space. Although our ninth grade science room consists of two classrooms and is one of the most modern and best equipped in the state, the working space for each person was very limited. In the smaller eighth grade classrooms it was almost impossible to have a class of 32 pupils working diversely; consequently, a great deal of the work was done in the school art and shop rooms.

No student was forced to participate in the fair but each was given a choice of making a project or taking a regular teaching unit for his monthly grade. After receiving the teacher's approval of the proposed project, the students began working on their exhibits at home about two months before the fair. One month of class time immediately prior to the fair was devoted to finishing projects and making posters explaining each exhibit.

Another problem was finding a suitable auditorium or other space large enough to present the approximately 300 projects which were completed. Since our auditorium and gymnasium were inaccessible, we arranged to stage our fair in the corridors of the basement and first and second floors and also in the school cafeteria. Each participating student was given a certain amount of space for his display and assigned a number. On the day of the fair the student body was required to get their coats and books before the last period so that they would not need to enter the halls after school. During the last period the tables were set up and the project numbers with the proper amount of space put into place. Each exhibitor was responsible for finding his number and setting up his project. Promptly at 3:15 the participants began assembling their exhibits and everything was completed and ready for judging by 4 o'clock.

Having to present the fair in the halls of the school constituted a greater handicap than was anticipated. The projects had to be taken down and the halls cleared immediately after the fair in order to ready the halls for classes the following day. This constituted one of our greatest pitfalls. If the fair had been held in a more suitable place the projects could have remained on display long enough to give all interested persons an opportunity to see the exhibits and also to permit the students more time to study

the many projects. Schools having large gymnasiums which could be utilized for a few days would not face this problem.

Although we allowed a month of class time to finish projects and work on posters we still did not complete all we had planned. We had hoped to give the students a few days in which to practice explaining their projects so that during the fair each child could stand at his exhibit table and be prepared to answer any questions which might be asked. Unfortunately we had not given ourselves enough time and this was not done. Consequently, many of the exhibitors were not fully prepared to answer questions concerning the technicalities of their projects.

An additional factor which we hope to stress somewhat more this year is the attractiveness and organization of the project from the standpoint of display. It has been our experience that in competitive judging there is often very little difference among several outstanding projects in so far as ingenuity, originality, and scientific achievement are concerned, and that in such cases, the judges are frequently influenced by such features as color, neatness, appropiate illustrations, and careful, informative labelling.

Relatively few failed to finish their projects. This failure was due either to the fact that the student chose too difficult a project and did not forsee the amount of time needed to complete it or, as in a few cases, did not work as steadily and conscientiously as was necessary. In the case of the former the student was not given a failing grade but was graded according to his effort.

In conclusion it seems appropriate to mention the benefits and satisfactions that were ours as reward for the effort expended in the organization of our fair. In planning the science fair our original goal had been to provide the students with an interesting as well as educational program in which they might experience the actual planning and preparation of their own projects. In this way we had hoped to stimulate interest in science as a subject and more specifically to demonstrate the many practical applications of science in everyday life. As we began to work with the students on their various projects it became evident that our original goals had been too superficial and that in the science fair we had a tool of almost unlimited potentiality. We found that the students were very eager to participate in this type of project and many students who had shown little or no interest in science previously were suddenly among the most interested. This interest carried over into other phases of their school work and school citizenship. It

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The Science Congress: Training Ground for Future Scientists

MADELEINE FRINK COUTANT
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THOUSANDS of school children participate each year in science events known as the Regional Science Congresses. The children start months ahead of time to work on projects of their own. They choose whatever interests them—perhaps polywogs, crystals, man-made snow, underwater photography or thixotropic suspensions. They develop the project as best they can with the help of their science teachers, reference books and experts in the community.

When the day of the Congress arrives these students come together from many schools to show each other their results and to have them criticised by competent scientists. Often, in order to accommodate the group, a large gymnasium is turned into a laboratory-for-a-day with special wiring, temporary gas lines and running water. The scene is one of great activity and interest is high as the pupils give accounts of their own adventures into the realm of science. Noted scientists quiz the students, examine their apparatus, and make constructive criticism. Outstanding students are recognized and all pupils are encouraged to continue their work in science.

A sign at the entrance of one of these Congresses might well read "Future Scientists at Work," for here is a field where science talent is being cultivated. The purposes of all this activity are to locate and encourage boys and girls with scientific promise and to broaden their horizons. The means by which it is hoped to accomplish these purposes is to set up an organization in which there is an opportunity to use the experimental method and to develop the scientific habit of mind. As such it is an organization that strikes directly at the heart of the current shortage of scientists and engineers.

The Science Congress was organized originally to give interested science students an opportunity to see and discuss the projects they carry on individually. It is intentionally patterned after the meetings of the scientific societies, particularly the Congress of the American Chemical Society. Each participant presents a "paper"

on his own individual project. Some of these papers are of theoretical and mathematical nature, for example: "The Implications of the Bronsted Theory" and "New Forms of the Periodic Table." Such papers are in the realm of scientific thought and are not necessarily accompanied by laboratory experimentation.

More often papers describe actual experiments undertaken by the student. Original records of data must be submitted and all sources of aid acknowledged. Since most of the experiments do not involve the expensive, stationary equipment associated with adult research, it is possible for the students to demonstrate at least part of their procedures and results. Creativity is stressed and many of the experiments show ideas and techniques that are original with the student. Occasionally truly original work is reported. A high school sophomore in biology discovered an unknown strain of bacillus subtilis as he searched for a new antibiotic. One of the girls prepared indium chloride by a new technique. Sometimes the experiment carries them into frontier fields where only top scientists can guide them. Vincent Schaeffer of General Electric, Frank Meleney of Columbia University, and Nobel prize winners Herman J. Muller and E. O. Lawrence have generously assisted in such cases.

At the single school or "grass roots" level in New York State, where the Science Congress originated and is most widespread, all pupils in the science classes and all others interested in science are urged to select and develop a project. On a certain day all the pupils are asked to present their projects in an all-school "science exhibit" or "science show." Usually no prizes are given, but all pupils with superior projects are identified by their science teachers.

Pupils selected in the school science exhibit are encouraged to enter the regional Science Congress. Scientists and science professors who specialize in the branches of science represented by the papers are invited to hear the papers and watch the demonstrations. They are invited to interview each participant and asked to discuss with him the quality of his work and to make suggestions for the future development of the experiment. These scientists also act as judges and evaluate with extreme care the thinking and the experimentation of each student. They rate the students and award prizes accordingly. Where a gymnasium is available, or facilities permit, the Congress is open to the public and all papers are presented to the audience.

A statewide Congress has been the logical culmination of this growing Science Congress movement in New York State. The

State Congress is now four years old. It has been made possible by the sustained, altruistic efforts of the State science teachers of New York, and the financial support from industry as in the case of the regional Congresses. The best three pupils in each of the eleven regional Congresses are eligible to enter the State Congress, where the thirty-three papers are presented in a two-day period. The counseling and judging procedures are essentially the same as in the regional Congresses. Colleges of the State have cooperated in making large scholarships available to State winners.

Over the years many of the participants have decided upon a career in science because of the encouragement, help, and promise offered them by the Congress. Those who take part gain an insight into possible careers and how rewarding each might be. It has been amazing to note that in some instances the career followed is almost an exact extension of the Congress project. For example, one high school boy who entered a project on crystals is fast becoming one of the outstanding crystallographers in the country. A girl who did tests on butter is now a home economist. A boy who worked on chemical action in photography is now head of one of the country's largest photographic studios. By contrast a boy who worked assiduously on hydroponics in high school is now a metallurgist. Another who was interested in fluoresence became a physician.

Even though the first winners in the regional Science Congresses are still relatively young men and women and even though the war years were "lost years" as far as their careers were concerned, many of these young people are making their mark in chemistry, metallurgy, medicine, engineering, physics. One young man is already assistant head of research for one of our oldest and finest chemical companies.

The students who present projects are not the only ones influenced by the Science Congress. It has penetrated the "grass roots" and challenged science students and teachers far beyond those who actually entered a Congress. All children, including those from elementary school, are invited to attend. In some of the Congresses the elementary children have a division arranged especially for them where they can show their own projects.

Colleges and museums, scientific societies, newspapers and others have all contributed in various ways to the Science Congress movement from its beginning. Great assistance has been given by local merchants, service clubs and many large industries including Ansco, American Telephone and Telegraph Company, Wood's Natural

Science Establishment, and International Business Machines, whose president, Thomas D. Watson, was one of the first to recognize the importance of this science event for boys and girls.

The main support, however, has come from the science teachers. The idea for a Congress was conceived in the years of the depression when teachers were returning part of their salary checks to their boards of education so that their schools would have money enough to keep going. During this period also, engineers were valued at "a dime a dozen." Yet at this time was introduced the Science Congress, an activity designed to challenge those boys and girls who could be our future scientists and engineers. Despite the handicaps, the Science Congress idea caught on among science teachers and students. Gradually more and more teachers appreciated its great significance in modern science education and undertook to sponsor them. These teachers found that organizing and directing a Congress added purpose, zest and satisfaction to their teaching and increased their prestige in the community.

The communities began to look upon their Congresses as fascinating science shows. Time was provided for spectators to examine each experiment closely while its owner explained, demonstrated and answered questions. Laymen appreciated this chance to see old and new experiments in science and to have them explained in language they could understand. As many as 2,500 persons took advantage of this opportunity at a one-day Congress in a small city.

Science Congresses were organized in many places and succeeded to the point that they was accused in 1944 of trying to turn all our able youth into scientists and engineers! Of course this objective was never directly sought. Considering our present shortage of scientifically trained personnel, such an objective might have proved a fortunate one. In any case the activity has contributed many competent scientists and engineers to our present and forthcoming supply.

It seems probable that the Science Congress has done much to solve the dual problem of procuring scientists for economic and military purposes and of providing the challenge and the opportunity for our gifted students to realize their maximum potential.

Fitting Science Fair Activities into the Total Academic Program

JOHN GAMMONS READ
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FAIRS are as old as civilization. The market places in Hong Kong, Istanbul, Edinburgh, and Lancaster, Pennsylvania, are more than commercial ventures. They are also places to display the uses to which mankind puts the products of his environment. The candlesticks in silver, the fine handmade linen, and the rich pastries are to be seen and appreciated by many, even though each can be owned and used by only one!

And so it is with science and mathematics fairs. They say "Come and see." It is almost a pity that they were ever labeled "science." They really are the total immediate expression of the work of young people who are finding interests and challenges in the world around them. This new world of consciousness is most vivid and meaningful when every teacher of every subject in the curriculum is eager to contribute to the development of projects for fairs. Let us see how the manual, creative, and aesthetic arts are involved, how the scholarship skills of library research and communications are used, and what traits of character are mirrored in the final exhibit.

Let's start with the character emphasis. No pupil ever finishes a project for exhibit in a fair without good solid work. First there is a period of planning, often cooperatively with his teacher, almost certainly involving his parents in a small financial measure. Then patience is taught, as the idea is worked on, as mistakes are made, as cage-doors stick, as colors splash in the wrong places. The discipline that showmanship demands is severe. Hundreds or thousands of people will see this bit of handiwork—and they will be critical. Perhaps never before has the youngster felt the power of public opinion. Expressions of thanks for help from others, polite questioning, careful letter-writing, all are concomitants. Finally, modest pride in achievement and the learning of how to accept awards or the real joy of seeing others get them make up for the sometimes fiercely competitive situations of fairs which have important prizes. Perhaps it would have been better not to have this competition. Judging is a serious business when it eventually may

mean a college education or none for a contestant; but awards are here, and are not foreign to American philosophy, both in school and out.

Essentially, the project or exhibit is a communication. A pupil has an idea, from which comes an invention. It must be put into language which everyone can read. People in great numbers will pass the exhibit quickly. Judges will stop a little longer. But the message must be clear. "I thought of this, and I wanted to tell you about it." This is also the problem of modern advertising.

A mature fair (that is, one in its third or later years) will present the same professional appearance as does an adult industrial or agricultural exhibit. Signs, display techniques, lettering, color, layout, and finish are all fused into a package which tells a story. Who helps to tell this story?

The influence of the art department is evident in the color, the design, and the lettering. Industrial arts contribute the layout and mechanical design. Commercial and typing skills are often evident in typed labels or in duplicated give-away bulletins. Most fairs have had to ban the purely ornamental or showcase lighting merely because there are not enough electrical outlets. But sometimes the union and the electrical service company run in special lines from the nearest heavy-duty feeder line, and set up power enough to allow for the display-lighting so beloved by youngsters. (Wires and outlets are carefully put away for other years—as they must be, for adequate wiring for a fair of 100 participants can run into hundreds of dollars.)

The teacher of the sales and distribution courses often has sent young people to specialists in the industrial or commercial field for information and advice. Of course, the principal of the school and his guidance staff will have unique information about parents' skills and hobbies. They will help. And everyone who has given help will come to the Fair!

What about academic subjects? No English teacher will mind checking displays for spelling. In fact, the science teacher who tries to do this himself is asking for trouble. Science gets in his eyes and blinds him to grammatical errors! Long before the deadline date (some two weeks before the Fair) individual pupils are bringing in parts of exhibits, copy, or photographs of too-bulky-to-handle displays to school for the English teacher to see. Note well this technique. There is no need for any elaborate administrative plan to get cooperation among teachers. What teacher can refuse a pupil's request for help in the teacher's own subject? "Miss Graham,

I want to make sure that all the punctuation is correct on my display." "This reference to *teosinte* I need to read for my report. May I borrow your Spanish-English dictionary?" "How can I be sure that these figures on the cards in the office represent the real IQ's of the pupils in my study of school achievement?"

Tape-recorders and record players are often part of an exhibit on sound reproduction. What shall the records be playing? When will the tapes of the electronic organ be used? The music teacher can make out the time schedule, suggest volume control, and see that the music will be pleasing to the visitors. But let the specialists take care of their problems. Here is a hint to the Fairmaster. He should never do anything anyone else can do better. And on the day of the Fair, he should have two young people, not exhibitors, one boy and one girl, by his side. They see a problem arise. They confer with the Fairmaster; a solution is suggested. One of them carries it out, reports back the result. The Fairmaster, of course, has absolutely *no* other job but to be there to solve problems. He'll be busy.

The social studies and mathematics teachers fall into a special category. Here there should be planned cooperation. No exhibit stands alone in science. Each is an exemplification of the interaction of science and mathematics with mankind. Judges' score cards take this into account, although indirectly in some cases. Careful preparation before a hammer or a paint brush is touched involves research into the history and geography of science. Look at this list of exhibits to see the relationship:

A Model of a Paper Mill
Heat-tolerant Breeds of Cattle
Cost of Household Electrical Appliance Operation
Development of Mono-rail Transportation
Glass Through the Ages
Swamp Flowers
Jet-engine Design
Rescues by Radio
The Magnolia, Its Care and Propagation
Man-made Satellite Orbits—a Study in Ballistics
The Manufacture of the Salk Vaccine
Pioneer Herbs, Drugs, and Dyes
Galileo, Gravity, and No Tower of Pisa
The Life Cycle of the Hookworm
Mendel and His Peas
Cotton's New Uses
Birds of the Southern States
A Graphic Presentation of Boyle's Law
The Ratio 1/1.1618 in Nature

Which of these is "pure" science? Indeed, on which of these does even the broadest, most-able science teacher wish to be the sole advisor? Rather, the pupil is the medium for gathering and transmitting information with help from other teachers, thence to the class, and finally to the public. The science teacher looks, listens, and gives encouragement.

Who learns from this process of learning and communicating? Who learns the most? Sit down, weeks after the fair is over, with the color slides of the exhibits and of the crowded hall. Go over them slowly, savoring them. See in them a new concept of what the school is for and what it can do. See also the interested faces of parents and friends in the community. And see there, most of all, the growth in the young people who became, for a day, like yourself. They had something important to say, so they taught it to others.

Our First Science Fair

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was evident that the competitive nature of the fair was stimulating and many of the students soon realized for the first time that "learning can be fun."

Other departments of the school were eager to cooperate in every possible way and the project soon became one in which the entire faculty and student body was taking an active interest.

From the standpoint of public relations the fair offered the parents an opportunity to witness the productivity of one phase of the school program and more specifically the productivity of their own children. For many parents this experience proved to be the stimulus that was needed to encourage them to take more active interest in the school and its objectives in relation to their children. For the children it was a stimulus for them to be at their best.

For these many reasons, our first science fair was a most rewarding experience for students, parents, and teachers, and particularly for those of us who were closest to it from conception to maturity. We are planning now toward our second annual fair on March 8, 1956.

Motivating Students and Selecting Projects

PHILIP G. JOHNSON

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IN A DISCUSSION of projects, it is appropriate that we have a definition of what we mean by the term "project." For my purposes a project is a voluntary science related activity in which some but not all students engage. The stress is on science related, on activity and on the idea that it is a voluntary and often a personal activity.

There are many types of projects, and this is necessary in order to meet the varied interests and needs of students. Some students like to make something. They like to make a pin-hole camera or a model of mitosis. They may wish to make a Geiger counter or a hi-fi system. Another type of project closely related to this involves the assembling and using of materials. An example here would be determining the strength of household ammonia, using burettes and related equipment. One could also assemble material in order to show Brownian movement or to demonstrate how to put together a radio. Then we have projects which are largely collecting and arranging. Students working on these types of projects have been known to collect ferns, minerals, insects, stamps and a large variety of other things—organizing them into planned sets, labelling and arranging them in an attractive exhibit. Some students, while they do not care to collect the materials themselves, like to collect photographs of the materials. Thus photography in relation to pictures of birds, clouds, stars, pictures of things underwater, etc., constitutes another type of project. We also have projects of the demonstrating type where a student may volunteer to help the teacher carry through regular or special demonstrations. These can be worked up partially under the guidance of the teacher and may help to enrich the science work for the other members of the class. Assisting the teacher also makes possible project work involving the conducting of reviews, the arranging of supplies in the storeroom, serving as a classroom consultant, and volunteering and serving as a class chairman or a class secretary.

Some students like to illustrate a variety of things. They may do it with pen and ink drawings, with water color or with oil.

They may make cartoons, lantern slides, charts, posters, or classroom murals. Then there are projects dealing with supplementary reading. Here students may make use of the books from the school, the community or a nearby university library in order to enrich their background in certain areas where they have a growing interest. Some students report on their supplementary reading in writing. Others become creative writers and, in that sense, writing is another type of project work. For example it is possible to encourage students to report a supposed conversation between a wise buyer and a salesman who may not know very much about a product. And again you can turn the table so that you have a student who has been studying the feet, as a part of his science work, reporting the conversation between a shoe salesman, who really knows about the feet, and a purchaser who has some knowledge about the feet. Then there are projects of the writing type. A student may select as a topic for a special paper "I Am a Telephone" and then report concerning the telephone, how it receives its vibrations and what it does with them in transmitting them to someone some distance away. Students often introduce some very pleasant humor into this type of a project. Students are often called upon to report their science project in writing to be eligible in some type of competition. Then again, some students, instead of writing in the conventional form, will write their report in the form of rhyme or poetry. Reporting may take other forms. It may be in the form of a tape recording or it may be popular writing for the local newspaper supplemented with a photograph of what is being reported. There may be exhibits along with a talk to a local service club or to a church-related group. Then there may be topics just for conversation at the family dinner table. All of these are worthy projects of the reporting type.

There is another type of project concerned with achievement tests. Here it is often exciting to encourage students to take various tests of high quality which will cause them to measure themselves against rigid standards. The annual Science Talent Search examination may be an example and we have other national examination programs that should be considered. Commercial agencies have tests in various subject matter fields which students may be encouraged to take as a type of project work. They will, in that way, be able to measure themselves against standards and then proceed to find out about the things which they have not yet learned.

Why should we encourage project work? In the first place it

reveals the spirit of science, the spirit of curiosity, the desire to search out answers, to try out things, to persist and carry through until a satisfying result has been attained. Beyond this attitude there is the possibility of encouraging students to continue learning often while other students are getting it for the first time. This is particularly true of our bright students who are often bored by the simple explanations necessary for a large number of students. They might be much more fruitfully engaged in some type of project work where they can continue to learn while other students carry forward their regular work. Because of this enriching feature, it is possible for these brighter students to enrich the classwork for other students by giving special reports and demonstrations. This is not necessary but it reveals a worthwhile possibility. Project work can also carry the message of science to others—to other students, to parents in the homes and citizens in the community, to scientists and to lay people. This is an important activity because students are able to communicate the spirit and the achievements of science to other people and spread a constructive feeling toward science among the people in the community. One should not overlook the fact that project work enriches the accomplishment of the teacher. It is wonderful to see how students can grow in project work if given a chance. They not only grow personally but they oftentimes involve other persons in their work, including adults in the community. One should not overlook the fact that those who are consulted also grow in their attitude toward the school and toward science.

How can we encourage project work? There are, of course, many ways of doing this. Some violate our attitude toward the voluntary way in which projects should emerge. I know some teachers who announce that no student will get an "A" or a "B" without completing some project work. They have the feeling that unless a student goes beyond the regular requirements he is not really above the average, since above the average is shown by willingness and eagerness to undertake and carry through project work. This is one way in which project work may be encouraged and once the student gets the taste of project work, it may not be necessary to exert this kind of influence to keep him working. A more acceptable way to encourage project work is to begin the very first day of school to suggest and to sell the value and the fun of projects. Here it is very desirable for the science teacher to begin selling his project work before the students get so busy with

other school related activities that they do not have time to undertake work related to science.

Many teachers require their students to keep some type of a notebook. A very simple way to begin project work is to encourage students to illustrate the topic or unit which they may have studied by special designs on the cover. Then if the teacher will display these notebook covers, it may encourage others to catch the idea and to begin, in this simple way, to do project work. Throughout the teaching it is desirable to toss project ideas at students. For example one can say "Wouldn't it be interesting to find out how many filling stations in the community actually use distilled water for filling car batteries?" Again, in a biology class it would be possible to say "Are there yeasts floating around in the air? If so, how can we prove that they are here; what kinds are there, and what do they do?" In an approach to the Christmas season, one might suggest that a student develop a simple device for testing Christmas tree lights to determine how long they are likely to burn. Again, a student may wish to make a yule log out of tightly wrapped newspapers which have been soaked with the proper chemical solutions and then dried.

One can also encourage project work by holding to at least one library period for each topic or unit. For this period, one should have made previous arrangements with the librarian to have a great deal of material out. Then take the class to the library and encourage them to look in the library materials for topics related to what has been studied in class. It will be unusual if many students will not elect to check out some of the books which they have found interesting and for which they did not have sufficient time while they were in the library. During your teaching it is possible to invite local resource people to the class and encourage them to participate in class activities. For example, a local dentist may come in and discuss some of the new techniques used in dentistry. A repairman for a television shop may come in and discuss some of the difficulties that people have with their television sets and what it takes to repair them. Some television shop may even be willing to take a boy on for Saturday work to clean up the shop and to be just generally helpful. This boy can grow into usefulness and will oftentime elect simple jobs in the shop as projects. The fact that little or no money is involved is perfectly all right since real project work is done for the love of working rather than for the money that there may be in it. Then again, teachers can definitely encourage project work if they will make it a point to end every

unit with at least one day for the exploration of ways in which the students can tell or extend what they have learned. This may mean that students will take what they have learned and put it in the form of cartoons, posters, news stories, and tape recordings.

If the teacher will arrange to keep a few of the projects or if they can persuade students to return and exhibit their projects to incoming classes, much encouragement will be given to a new group of students. If this is impossible, it is possible to photograph project work so that incoming classes may see what others have done and catch some of the enjoyment and zest which grows out of such activities. Tape recordings prepared by former students who have worked out projects can also be used. Newspaper reports of previous project winners represent a possibility for feed-back to a new science class.

Special occasions may provide encouragement for project work. There may be a local photographic salon and some students interested in photography may be encouraged to prepare for the competition. The local science fair or congress may be ahead and the teacher can encourage students to get ready. There may be a school open house when parents come to the school and visit the classrooms. The teacher may encourage students to prepare exhibits and to arrange materials for such a "Parents' Night." There are many special occasions of the school variety such as an assembly program or a homeroom program where students may wish to prepare materials for the pleasure of preparing them as well as for an exhibition that others may see.

You have noticed that my remarks give little attention to competitions, exhibitions and displays. It is my conviction that project work is so valuable to the student and to the teacher that it should be encouraged even if there is no opportunity or desire for public recognition. This leads me to my final and most significant suggestion. The best way to encourage project work is for the teacher to engage in such work. The teacher will then show both the curiosity characteristic of scientists and the joy that project work provides. Interest in project work is sure to grow under such a teacher.

Promotion and Public Relations of Science Fairs

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ACTIVITIES designed to assist in relieving the shortage of scientists and science teachers have been started in several directions. One of the most promising of these is the development of the Science Fair movement. The aim of this discussion is to illustrate how the promotional activities in one region of our country are used in furthering this Science Fair movement and thereby increasing science interest among our students and teachers as well as the general public.

The terms "promotion and public relations," as understood and applied in furthering the success of our annual San Francisco Bay Area Science Fairs, cover a great deal of ground. In fact, it has been our experience that the two are not only closely interrelated, but in more or less degree are called into play on virtually every phase of the organizational work and of the many practical details involved in the actual staging of the fairs.

Lest there be confusion, it should be understood that the reference here to public relations is made in its broadest sense, and does not mean publicity alone, which is only one of its aspects, although an important and essential one.

Everyone connected with the fairs is contributing in some measure to the public understanding and support which are the objectives of any public relations program. In addition, many are engaged in activities which are directly promotional in their purposes. These activities can be grouped under three headings:

1. Enlisting the interest and participation of school authorities, of science teachers and, as the chief end result, of the students.
2. Raising funds to finance the fair budget each year.
3. Publicity through newspapers, TV and radio stations, teachers' journals, scientific and technical periodicals, and a speakers' bureau.

It may be of interest to review some of the procedures followed in connection with the foregoing in the San Francisco Bay Area, along with a few observations on their effectiveness and long range

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value. Undoubtedly much the same pattern prevails in the other Science Fair areas.

Soon after the start of the fall semester each year the executive director sets out upon a series of special meetings with junior and senior high school teacher groups throughout the twelve counties of our Bay Region. Paving the way for these meetings are letters to superintendents, principals, and science teachers. The first of these communications is in the nature of a general announcement. Superitendents were addressed this year as follows:

> The third annual San Francisco Bay Area Science Fair is now in the planning stages. With two successful fairs behind us we hope this one will be even better. One hundred and two schools participated in 1955 as compared to seventy-five in 1954. Our grand prize winners in both 1954 and 1955 received additional honors at the National Science Fairs, and of this we should be justly proud.
>
> The 1956 National Science Fair will be held in Oklahoma City and the 1957 Fair in either Los Angeles or San Francisco. Our Fair will be presented April 7 through April 11.
>
> A large part of these past successes was due to your fine cooperation with us. We would again like to enlist your support for the 1956 Science Fair. Some of the schools in your area participated last year, but perhaps a word of encouragement through your bulletins and other means of communication would interest more of your schools in participating in this worthwhile science activity.
>
> Last year we met with a number of teacher groups in the various counties. Discussion and slides about the past fair, as well as techniques which the teachers and students might find useful, formed the program. If any of your teachers want to have such a group meeting the coming few months, we shall be glad to assist.
>
> Further communications will be sent to your principals and teachers from time to time."

The meetings and other direct contacts with school authorities and teachers, and through them with the students, obviously form the most basic of all our promotional activities. While adequate financial support and the generation of public interest in the fair and its aims are of course important factors, true success must always rest primarily upon the degree of interest and active response achieved among the teachers and students.

In seeking this result it is inevitable that our efforts should serve not only to promote participation in the fair, but also to produce a wider awareness of the underlying purposes of this movement.

In our region we have observed a steadily rising recognition of the Science Fair as one of the best means ever presented for advancing the place of science studies at the preparatory school level.

This groundwork, we have found, is being translated directly and effectively by the teachers into steadily greater student participation in the fairs. The more serious science students respond to the fair as a means of achieving wider recognition for their talents and thus being stimulated to further effort. Other students are prompted to make their science studies a completed pursuit instead of a mere dabbling.

In promoting student participation the factor of self-interest as well as that of the national welfare is strongly stressed to them. The opportunities for careers in scientific and technological fields and in teaching are pointed out not only by their teachers but by industrial executives both in talks to student groups and through public statements in the press.

The promotional efforts of the executive director extend beyond general missionary work and include considerable personal assistance to the teachers on the many practical details involved in preparing for the fairs, which they lack the time to carry on by themselves.

Outside the schools are other areas of activity in which there is an intermingling of promotional and public relations procedures. The work of the budget committee, by its very nature, calls for the employment of efforts which fall under both headings, although there is no public drive for funds. These are raised entirely by personal contact, mainly among large business and industrial firms and educational scientific and technical societies.

Support of the fair from these sources is not limited to financial contributions. It also includes the donation of managerial skills and experience and time which are invaluable to the successful conduct of our fairs. These are made available through an advisory board of industrialists and educators headed for our coming fair by Mr. R. G. Follis, Chairman of the Board, Standard Oil Company of California; a planning board of similar composition; a publicity committee; and a budget committee from the business world.

Each of these groups is concerned not only with carrying on its allotted functions, but each is active in the general promotion of the fair as an established project of proven value in meeting a grave national problem.

Our operating committee, charged with the many arduous duties involved in the actual physical staging of the fairs and numerous related details, handles a variety of problems of public relations importance: the provision of adequate exhibit space and suitable conditions; the selection and design of awards; hosting the large

board of judges and facilitating their work; performing many other tasks concerned with the smooth handling of a public event attracting upwards of 10,000 visitors a day—a total of some 60,000 last year.

This committee, the major working force for the fair, is composed mainly of junior and senior high school science teachers, who each year devote many hours of their own time to the responsibilities placed upon them.

The board of judges by its very composition has certain definite public relations and promotional aspects. Serving by invitation on a panel of some sixty members are prominent scientific figures of our region, university and college professors, heads of research institutions and technical societies, and scientists and engineers drawn from the management levels of our major industries and business concerns, and a few teachers. Their names and reputations contribute materially to the prestige of the fair, in addition to enhancing the importance of the awards in the eyes of the students, their teachers and parents.

With reference to prestige, a contributing factor of great value is participation of the National Association of Manufacturers through the presentation of the special "science in industry" programs at the fair. The NAM also plays host to the winning students and their teachers at a luncheon in their honor.

Bringing public attention to all of these activities and aspects of the fair is a program of publicity, carried on principally through news releases to the daily and weekly press of the region, school publications, and certain trade and technical periodicals. Effective use is also made of donated radio and TV time. Participating students appear on scientific programs both before and after the fair. Last spring the fair was the subject of an on-the-spot telecast review on the popular weekly "Success Story" program. A publicity committee composed mainly of men from industry and the newspapers with a publicity director make this possible, thereby relieving science teachers of many details and time-consuming tasks.

Summing it up, promotion and public relations for our Science Fair draw upon the voluntary services of specialists from a variety of fields, while at the same time leaving basic control of the fair in the hands of the educators. The result has been smooth and productive teamwork, promising the continued growth and success of our annual Science Fair.

Preparing and Displaying Exhibits

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THE GERM of a good science fair exhibit is an idea. The better the idea, of course, the better the exhibit. But there are many kinds, or levels, of ideas. The lowest level, perhaps, is to take somebody else's idea and make a copy of it. Even though the resulting exhibit might be interesting and well constructed, the project will be of little value from the scientific point of view to the student. Educationally, such an approach is about as valuable as copying an arithmetic problem or an English theme.

PREPARING THE EXHIBIT

Science fair exhibit projects should further the teaching of science. This should be kept in mind at all times by those who are responsible in setting up science fairs and for guiding students in project activities. The highest idea level is one incorporating something new, something original. Such concepts, it is true, will be rare, but they are not beyond the creative ability of high school students. Between these extremes are many other idea levels, but the planner should always strive for originality and creativity. This may take the form of an improvement. There are few basic patents but there are many refinements.

Once a student has decided upon a idea, the next step is to develop the idea to give it what might be called "scientific depth and breadth." By "depth" is meant an expression or utilization of scientific principles. Exhibits which express an application of the scientific method will, if the methodology is complete and the deductions and generalizations are sound, attract the attention of competent judges. Generally speaking, such exhibits score very high in competition.

By "breadth" is meant the amount of information which has been drawn upon or utilized in developing and constructing the exhibit. In this connection teachers or advisers should endeavor to guide students into developing exhibits in a manner which will be "mentally stretching." The project should present a problem which should be thought through and which should further force the student to search out additional information and facts. An exhibit which is merely an expression of what might be termed

"residue knowledge" defeats in a large measure the purpose of the project. Such an approach greatly minimizes the educational value of the fair.

The third step in preparing an exhibit is that of translating the developed idea into concrete form. Here there is a sharp break in the approach to the project. In the first two steps the preparation has been completely in the realm of the abstract—of "ideaness." It is now time to express the developed idea in a "seeable and touchable" form, that is, in an exhibit: a material thing. This translation from the abstract to the concrete is, in many cases, very restrictive. For example, there are limits on the size of exhibits. Also the cost of materials may limit the completeness or effectiveness of the exhibit.

An exhibit must be considered not only concrete expression of a developed idea but also a medium of communication. This is very important, for exhibits must convey the development of the idea to the judges. In other words, the exhibit must "talk" to a group of experts who are charged with evaluating the exhibits on the basis of certain predetermined standards. These standards, usually five or six in number, have been allocated point values. In this connection, it is assumed that the science fair is organized as a contest: that is, the exhibits in certain scientific areas and within a group of school grades are competing with each other in terms of excellence. It is further assumed that the students will not be present at the time of judging, thus throwing the complete responsibility of communication between the student and the judges on the exhibit. It should be stated, however, that there are some science fairs which are organized so that the exhibitor is present at the time of the judging and is questioned by the judges about his exhibit. This is a very commendable procedure and should be encouraged; it has great educational value. In most fairs, however, as has been pointed out, the exhibit must "speak" for the student.

Science fair exhibits may be of two types: individual and group. An individual exhibit is one which has been constructed by a single student. A group exhibit is one which has resulted from the efforts of two or more students. Generally speaking, more individual exhibits are found in the higher grades; group exhibits predominate in the lower grades. Thus, before beginning a science fair project, the student must decide whether he will work alone, under the direction of his teacher or an adviser, or whether he will team up with one or more partners who are interested in developing an idea and in constructing an exhibit. There are values in both approaches.

In connection with the group approach it might be pointed out that much present-day high-level research is done on the team basis.

Before developing a project, students should know the standards or criteria by which their exhibits are to be judged. Such standards are usually printed in the announcements of fairs. Before starting to develop an idea, a student should obtain a copy of the standards and study them carefully. The explanations of each of the criteria give many excellent suggestions for the development of an idea and the construction of the exhibit. The value of this step in the preparation of an exhibit cannot be overemphasized.

The selection of an adviser for the project should be made very early by the student or the group. The classroom or science teacher generally "gets the call" of being the adviser. There are many instances, however, when the teacher in not the best person to act as an adviser. The best person is the individual who knows the most about the idea which is to be developed.

Every community has specialists in many fields of science. The county agent can advise in many topics of interest to the rural student. Radio and television technicians are trained in the field of electronics. Doctors can advise in a large number of topics such as blood, nutrition, and health projects. Industrial chemists have assisted many students. The teacher, principal, and PTA can be very helpful in finding the best qualified adviser. Do not overlook the valuable personnel resources in the community.

As has been pointed out, the exhibit must "talk" to the judges. Because of space limitations, captions in many cases cannot tell a complete story. An exhibitor should not hesitate to supplement the caption and placard diagrams by using a book containing further explanatory material and additional diagrams. The public may not look at the book but the judges will. It should be remembered that a science fair exhibit is not developed to "talk" to the public but to the judges. Science fairs are not run for the public but for the student. Public attendance is permitted, even invited, at most fairs. The more parental and public attendance the better. But it is incidental to the main purpose of the fair. An exhibit or its explanatory material should never be "slanted" toward the public.

In presenting the idea development through the exhibit, the captions and supplementary materials should follow a logical sequence: that is, unfold the story in proper order. The more important steps should be emphasized by some methods such as larger captions, fuller explanations, arrows, color illustrations. This will

focus the judges' attention on those aspects which the student regards as important. It will also assist them in evaluating the exhibit. Scientific knowledge is ordered knowledge, not just rambling factual information. Logical classification and sequence should be utilized in explaining the development of the idea to the judges.

The exhibit, above all else, should be scientifically accurate. The writer once watched a group of five well-qualified judges study an exhibit setting forth a rather complicated chemical-separation process. It was an elaborate-looking exhibit with many labels containing chemical formulae. There were arrows showing flow directions. There was even a supplementary book. It was evident that the two students who had constructed it had spent many hours of work in the planning and assembling. But one of the judges suddenly remarked, "The process, as shown, won't work." The other four judges quickly agreed. One step in the process was inaccurately presented. The students could qualify only on the basis of effort. Effort is, of course, useful in any scientific endeavor, but is valuable only when it produces accurate results.

DISPLAYING THE EXHIBIT

When a student brings an exhibit to a science fair, a great deal of planning must have been previously carried out in order that the exhibit may be quickly placed on display in its proper spot and hooked up for operation. Entry blanks are required in many fairs. Small fairs, such as the classroom type and even fairs in small schools, can be held without written advance information. An entry blank, however, is essential to the efficient planning of all medium and large-size fairs. In such fairs, because of the number of entries, display space must be conserved. It is an unnecessary waste of such space to allocate the maximum amount allowed by the rules when it is not actually needed.

Entry blanks have a section requesting information which makes it possible to pre-plan the entire display of exhibits. Questions of the following type are usually asked: (1) length of exhibit..... inches; (2) depth of exhibit.....inches; (3) electrical outlet needed? (Yes) (No); (4) display backboard needed? (Yes) (No).

With such information, it is possible to make a scale drawing of the entire arrangement of exhibits as soon as all entry blanks have been received. Display tables must, of course, be arranged for in the advance planning. A simple, inexpensive, yet adequate table can be made by boards on lightweight saw horses. In many schools these horses have been constructed in the manual-training shops.

They can be compactly stored by nesting and used year after year. Local lumber yards have assisted great numbers of fairs by lending the necessary lumber.

After the improvised tables have been set up in the room or hall which has been selected, they are generally covered with a heavy brown wrapping paper which is taped or thumb-tacked to the boards. The tables are now ready to be marked off for the exhibits. Since this has already been done earlier in the scaled chart from the data received on the enry blank, it is a very simple matter to mark off the required amount of space on the table. Electrical outlets and backboards must be provided at proper places. In order to save work and materials it is common practice to arrange all exhibits requiring electrical outlets or backboards together.

Fairs which are open to several grade levels, such as high school, junior high, intermediate, etc., should have the exhibits for each of the grade levels displayed together. Within each of the vertical divisions (grade levels), exhibits should be arranged according to the scientific areas, such as physical and biological sciences. Other values accruing from arranging exhibits in this manner are these: (1) it greatly facilitates the judging, and (2) it allows the audience to compare like types of exhibits from the same grade range with each other. For example, junior high school biological exhibits may be studied as a group, since they are placed side by side.

Upon receipt of the entry blank, some of the larger fairs send the exhibitor a registration card which is divided into two parts. On the day the exhibits are to be placed on display the exhibitor presents the card at the registration desk where it is torn in two. One part is stamped "Received" and placed in a file; the other is returned to the student, with a number taken from the assignment chart which gives the location on the tables. Since the space has previously been marked off and numbered, it is very easy then for the student to find the location and place his exhibit on display. Thorough pre-planning makes the placing of exhibits a quick and relatively simple matter. It is worth all the detailed work that goes with it.

Judging Exhibits and Awarding Prizes

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FUNDAMENTAL to any worthwhile evaluation of science fair exhibits is the agreement that each student shall reveive a personal appraisal of his efforts. This is particularly true at the local level; and, as a policy, should, it seems, be extended to district, state and national fairs as well.

Constructive evaluation of individual projects does not prevent certain projects being earmarked as superior for specific well-defined reasons. Whatever classifications are open for competition will eventually have their winners, but winners and losers alike should know wherein lies the excellence of each winning project. Constructive, creative, and imaginative criticism can do much toward encouraging additional work of a sound nature among all participants. And this, judges should remember, is one of the underlying factors prompting the use of science fairs.

Teachers and students should realize that scientific research, even if on an elementary level, is the fundamental reason for encouraging projects and science fairs. Presumably, then, any student exhibit or project will be the result of some interest or curiosity. Whatever might be the initiating cause, there developed within the student a strong desire to get an answer to a question or problem or to have a better understanding of a scientific principle. It is as if the student is in one location and wishes to go to another place but there is a barrier between the two. In order to overcome this barrier he finds that he must have more knowledge about a particular topic or topics. Thus the student begins to work on his problem. He has to read, take notes, make observations, talk with qualified persons, take a field trip, experiment, design and build a project, or use any approach which he feels will be profitable. When the result of his work is placed before the judging team, it should be examined with this thought in mind: what question or problem was the student trying to answer or solve or what important scientific principle was the student trying to explain or illustrate? This question or problem need not be of a complex nature. For example, a simple controlled experiment might have far more value than a complex gadget which shows

little scientific knowledge but only a high degree of mechanical skill on the part of the student.

A judging team will look for exhibits that "catch the eye"—exhibits that are neat, attractive, well-displayed and which show a creativeness on the part of the student. This is a fair in which there are many entries and all must be judged; but the ones arousing curiosity will receive more careful scrutiny. It is not the type of showmanship that is characterized by glaring neon lights which is desired, but rather a carefully planned combination of colors, materials, and interesting arrangements. Exhibits which arouse the curiosity of the judges because they are displayed in an interesting manner and which show a high degree of scientific work by the students are possible winners.

A judging team will always face one limiting factor—sufficient time to do a thorough job. This will be true whether it is a local school fair or a district or state fair. This will result because of the number of exhibits to judge and because some time should be devoted to a brief discussion with each individual student and with the science teachers. The question arises, then, as to how a judging team can use its limited time to maximum advantage. A first step to take is to have the judging team well-oriented as to its duties and to have it organized so that it can function efficiently and effectively. The orientation and organization can be accomplished more easily if the proper persons are selected to judge. In a general way one might list the following qualifications for judges: (1) good training in either the biological sciences, the physical sciences, the earth sciences, or in specific areas of the larger scientific fields; (2) acquaintance with the science program of junior and senior high schools; (3) recognition of good techniques of science teaching; (4) a keen interest in young people; (5) a desire to help improve the science work of the students. These factors indicate that a judging team might be composed of several persons whose interests and training are in botany, zoology, physiology, ecology, chemistry, physics, geology, meteorology, electronics, and the like. In addition there might be one or more persons who might be classed as science educators. Therefore the team might be organized into two groups: (1) several persons trained in biological sciences plus a science educator; (2) several persons trained in the physical sciences plus a science educator.

A second step to take is for the judging team to make a brief survey of all the exhibits. This can be facilitated if the fair committee will do the following: (1) group the exhibits according to

the classifications to be used; (2) prepare a simple worksheet for the judges; (3) have each student with his exhibit. On this worksheet will be given the name of the exhibit, the name of the student and the number of the exhibit. To simplify the numbering of exhibits, the numbers from 1-250 might be reserved for biological science exhibits and the numbers from 250-500 for physical science exhibits. As a judge moves from one exhibit to another and talks briefly with the students, he can easily and quickly indicate on the worksheet whether or not an exhibit looks promising.

After this rough survey is made, a more refined process should be used. If the work sheet mentioned above has three or more columns on one side, it can be used for this stage of the work. The following items can be used to evaluate the more promising exhibits and the results tabulated in the columns:

(1) Does the exhibit give an answer to a question, a solution to a problem or clarify a scientific principle? .....points

(2) Does the exhibit show creativeness? .....points

(3) Is the exhibit attractive? .....points

The next step will be to select the best, whether it be one or several. To do this a more complex system seems to be necessary. The following score card, used at the National Science Fair, might be adapted for this process.

Creative Ability—30 points

Does the exhibit show originality of thinking and of illustrating a scientific principle?

Scientific Thought—30 points

Does the exhibit show evidence of well-organized work, an extensive searching for facts, or the use of controlled experimentation and a careful analysis of data?

Thoroughness—10 points

Does the exhibit give a complete story of the scientific principle or scientific process involved?

Skill—10 points

Does the exhibit show good workmanship in the handling of materials? Was the exhibit made from raw materials or were the materials purchased?

Clarity—10 points

Does the exhibit give a picture that the average person can understand? Is the exhibit neatly described by guide marks, labels and drawings?

Dramatic Value—10 points

How does the over-all attractiveness of the exhibit compare with others in the same category? Does it "catch your eye?"

Exhibits have been judged. What kinds of awards are to be

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Reviewing and Evaluating the North Carolina Science Fairs

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THE 1955 Science Fairs in North Carolina accomplished to some degree all of the objectives of the sponsoring organizations. Some 4,000 junior and senior high school students participated in the 25 local fairs throughout the state, and introduced their work and talents to some 10,000 people who attended these fairs. These boys and girls had the opportunity of comparing their work with that of their classmates and friends, and of receiving the beneficial criticism and advice of the general public and of the judging committees who evaluated the work.

The six district fairs had some 800 students exhibiting, and some 300 essays entered. These activities on the campus of six colleges in the respective districts attracted some 3,000 spectators who had their first chance to see just what the high school science people were capable of producing. This gave the scientists of the various districts an opportunity to meet and observe the best high school talent in their area. The science fair offers the scientist the same opportunity for scouting that the high school football game offers the college coach. With the acute shortage of scientific personnel facing the state and the nation, this can prove one of the ways of finding boys and girls with the desired interests and abilities for meeting these needs. The district fairs also provided an opportunity for the junior and senior high school science teachers to meet with their colleagues, to see what others were doing, and to evaluate their own work. This also gave the college scientists a chance to become acquainted with the high school teachers of their area, and should result in closer cooperation between the two groups.

In general, the better exhibits came from those schools where preliminary selection had been made in local fairs, and the winning students had had time between the local fair and the district fair to make corrections and revisions in their work in keeping with the suggestions that they had received during the previous competition. Excellent exhibits are the result of many hours of study and work, and require constant checking for possible improvement. While the exhibit must be the work of the individual

student, there should be constant advising and criticism from any person who can help improve the finished product. Many of the exhibits could have been improved by proper supervision from the teachers of art, English, shop, and various others in the public school field, or by specialists from outside the schools. Scientists, engineers, technicians, craftsmen, and many other people of the community can add much to the finished exhibit if the student is placed in contact with them.

While some of the essays submitted were really of superior quality, many of those read by the judging committees were of a nature that did not indicate real cooperative effort on the part of the student and the school faculty. The essay contest of the science fairs offers an opportunity for the effective application of scientific research and scientific writing. These papers should be the results of the combined efforts of the student, the science teacher, the English teacher, the librarian, and the social science teacher. Participation in the essay contest can be just as valuable in the development of the future scientist as participation in the exhibits. It is desirable that the better students work in both categories and develop both the ability to create the exhibit and to write the results of their research.

The fifty-nine exhibits at the State Science Fair represented the best from the 4,000 participants in the local fairs and from the many schools that did not sponsor a local fair. These students meeting together with the high school science teachers, college scientists, research scientists from industry, and school administrators provided an excellent opportunity for communication between the groups. The quality of this fair was indicated when the winners in both the biological science division and the physical science division were honored with a fourth place recognition in the National Science Fair. This in itself is no mean accomplishment in the first year that North Carolina has attempted a state-wide system of science fairs and for the first time that an entry has been made in the National Science Fair from our schools.

The North Carolina Academy of Science paid the entry fee for the two state fair winners and their home communities provided a fund to cover their expenses in attending the national fair. This was satisfactory as a beginning venture, but it is desirable that this expense be assumed by newspapers, radio, and television for its news value, or by various industrial organizations who are interested in promoting future scientists as a part of their public relations program. It is entirely feasible, and really desirable that repre-

sentatives be sent to the national fair from each of the district fairs just as soon as interest and funds are available at the local level. This should be one of the long range objectives in the science fair program. It is also desirable that scholarship funds be established to aid worthy students in continuing their scientific education.

The original State Science Fair operation in North Carolina in 1955 was a most profitable operation for all concerned. Greater benefits can be obtained when more local schools sponsor their own science fairs, organize local science clubs, and resort to more emphasis on project work on the part of the science students. Science fair activity should start in the science class, where the greatest benefit from the fair activity is obtained. There is no doubt that the most important science fair is the one held in the local school where the students, their teachers, and the community can share the benefits.

Judging and Awarding

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given? Fortunately they can be of many types, of which monetary awards are probably of the least value. In local school fairs the use of certificates of merit to which are attached either blue, red, or white ribbons seem to serve the purpose well. In district fairs there might be awards such as books, supscriptions to scientific magazines, memberships in the Junior Academy of Science and pieces of apparatus such as inexpensive microscopes in addition to the certificates.

Finally the day arrives when the best 50 to 100 exhibits, selected from several thousand over the state, compete in the State Fair. All are really blue ribbon exhibits, but the top two with many honorable mentions are selected. To the two persons whose exhibits are judged to be superior to all the others is given the opportunity to exhibit in the National Fair. They actually will represent all the schools of the State when their exhibits are placed alongside those from other states in the Union. Here is a never-to-be-forgotten award for the many hours and days of hard work that were invested in the exhibits.

Educational Implications of Science Fairs

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SCIENTISTS and educators today generally agree that all students should have an opportunity (1) to acquire a functional knowledge of the facts and principles of science, fundamental to an understanding of themselves and their environment; (2) to become acquainted, and acquire a modicum of proficiency, with the methods used by scientists; (3) to become familiar with the influence of science on human life and thought; and (4) to acquire an interest in and knowledge of the processes of investigation and learning so that the individual may cope adequately with new problems and new ideas as an adult.

It takes a special kind of science teaching to achieve the purposes enumerated above. This special kind of teaching is a kind which will yield student work that can be reported in school, area, state, and national science fairs. Our objective is good science teaching, however, and not the preparation of projects to be exhibited in a science fair. Therefore, our evaluation as to whether it is worthwhile to pursue a certain idea in science is based on the educational value to the student rather than whether the development of the idea would make a winning project for a science fair.

Teachers should encourage extraclass activity, ranging from homework on a particular phase of the subject being studied to the serious investigation of some problem growing out of the work. Teachers should make the apparatus and equipment of their laboratories available—as books of the library are available—for use at home or at school. Students, of course, must recognize the limitations of these instruments and the nature of the care required in their use, but the instruments should be available for student use throughout the year. On this basis a community will support the program, for so much good is visible.

The local science fair will serve to acquaint all the people of the community with the progress of study in school science classes. It will also call attention to various needs for counselors in certain areas of science, and for help from scientists, engineers, and others who can work with student and teacher in certain specialized areas of investigation. The need for new instructional materials and the

use of existing materials will become more evident to the public who must procure these materials.

The public will become more aware of the contributions of scientists and of the soundness of the methods of science when the young people of their community are actively interested in a number of scientific investigations, the results of which all may see at the science fair.

The science fair with its opportunity to report the results of student investigation will encourage classes in science to be conducted more nearly as a director of research would conduct the work of his team of researchers. The teacher, who now becomes a *teaching scientist,* must be an able student of the unit of work under study. He understands that he must teach certain fundamentals—that it is not possible in a short period of time for each student to obtain firsthand all knowledge (in the areas) that has come in the development of civilization. He will see that much knowledge is transferred by the written and spoken word.

The teaching scientist thinks of the laboratory as a place where physical facilities exist for the study of problems arising out of the study of the unit. Instead of relying on conventional experiments appearing in text and manual, the teaching scientist sets out with his students to find answers to questions which have been developed by the class and which have resulted from reading and the conference consideration of the topic being studied. Many of the experiments which have been referred to in the literature will have been set up by the teacher as a demonstration or by a student or small group of students for the same purpose.

Students individually and in small groups now begin the study of facets of the topic under general study. The teacher is now "director of research" as he directs these investigations. People from the community, with knowledge in the specific area of the problem of a student, may be asked for counsel. Special apparatus may be needed for a limited time and may be borrowed from a local industry, research laboratory, or university—or part of the work may be carried out in the laboratory of the industry, research institute, or university. Laboratories of hospitals and clinics should not be overlooked.

The teacher does not require the completion of a given exercise each day but does expect a gradual gain in understanding as well as continuous study. There should be conference sessions, similar to seminars, with progress reports. In these meetings students will

report what they have learned through reading, through talking with others, and through their investigation, that all may share in these understandings.

Each student is expected to take some initiative and to contribute to the over-all development of the unit. One student may be very able in a theoretical sort of way, capable of reasoning in the abstract. Another may not be able to contribute ideas, but he may be able to take an idea and make a model exhibiting fine craftsmanship. Both are needed in our society and both will find an opportunity to exhibit in a science fair, the one through narrative, graphs, figures, and data, the other by a model. There is room in between for each of the remaining members of the class according to ability, for the science fair provides a place for each student with an interest in science.

The teaching scientist serving now as a research director must have appropriate materials, books, and apparatus available. He must be able to advise students, but he need not know all the answers. In research, one is trying to find answers to problems. Primary concern will be with the growth and development of students, not with the number of pages of text covered or the number of laboratory experiments completed.

Class sessions will not be periods of parroting text material but periods of thinking based on information gained from many sources. Students should acquire sound reading habits, and learn basic principles, methods, and techniques that will prepare them for college or continued study on their own.

The special kind of science instruction referred to above—a kind of instruction particularly motivated by the science fair—should result in stimulating the natural curiosity of the student since within wide limits he may investigate a problem of his own choice. This should result in increased enrollments in science which in turn will be stimulated by interest in the work of science classes as reported to fellow students and parents through the science fair.

Science fairs lend encouragement to the establishment of an offering intended for the students with special interest in science—a course where students can carry on an intensive investigation of some problem under the direction of any one of the teaching scientists in the school. To establish such a course would require (1) the desire for this kind of instruction on the part of all teachers; (2) a place in which students can conduct a continuing investiga-

tion; and (3) material facilities, tables, services, apparatus, and library.

The kind of instruction proposed will encourage more out of school study. This study should be further motivated by providing kits of apparatus planned for the support of the unit of work under consideration. In the study of "light" in physics, for example, a kit of lenses, prisms, etc., would make it possible for the student to acquaint himself with all the experimental ideas usually suggested in the laboratory manuals as he goes about his study. As an example, he can test the methods suggested for the measurement of the index of refraction of a piece of glass or transparent plastic as he studies the topic. The use of this kit of apparatus in home study relieves much precious class time for the laboratory investigations suggested earlier.

The science fair, with the kind of instruction which it fosters, also encourages continued study on the part of those who have investigations under way. Such study may extend through the vacation months and justify the use of school facilities during vacation time. The science club is a natural companion organization to this type of instruction. A father-son, or better yet a parent-student club, is envisioned to provide extended opportunity for effective work with the teaching scientist as sponsor.

Science fairs, then, stimulate science teaching and science learning activities in the schools which bring students much closer to science and scientists. Under these conditions the student can decide whether science is, or is not, for him. Whether he chooses his career in science or not, he is more likely to have the attitude of a scientist in the decisions which he must make as a citizen.

Scientists will be able to work more effectively in a society where individuals have an understanding of and an appreciation for science. Capable scientists will develop in larger numbers in a society where good instruction in science is a part of the education of everybody.

Audio-Visual Materials and Techniques

KENNETH M. MCINTYRE
Bureau of Visual Education, Extension Division, University of North Carolina

FILM NOTES

• **ATOM SMASHERS, EBF,** 12 minutes, 16mm, sound, black and white. Describes how scientists are developing machines and techniques for the production and use of nuclear radiation in many fields. Calls attention to the importance of accelerators—particularly the cyclotron—and their contribution to nuclear research. Illustrates how the products of "atom smashing" are identified, and demonstrates measures taken against the dangers inherent in this research.

• **ATOMIC RADIATION, EBF,** 12 minutes, 16mm, sound, black and white. Explains fundamentals of atomic radiation: the dramatic story of its discovery, what it is and does, and why it should be respected rather than feared. Describes how it has been possible to reproduce in the laboratory some of the forms of radiation found in nature. Explains the roles of alpha, beta, gamma, and neutron particles in research.

• **BIRTH OF THE SOIL, EBF,** 10 minutes, 16mm, sound, color. Reveals how man's very survival depends upon a few inches of topsoil which only nature can manufacture—and over a period of many centuries. Explains the remarkable process by which life-giving topsoil is produced from the basic raw materials of rock, water, air, and sunlight. Contrasts the productive capacity of topsoil with that of subsoil.

• **CARBON FOURTEEN, EBF,** 10 minutes, 16mm, sound, black and white. Explains the use of radiocarbon (carbon 14) as a means of determining the age of ancient objects. Defines "half-life" in clear, lucid terms. Illustrates the role of carbon 14 in tracing the vital processes of growth in living things. Shows how carbon 14 is permitting an approach to a solution of the riddle of photosynthesis, and how it has an important bearing on observational methods in life sciences.

• **CHEMISTRY AND A CHANGING WORLD, EBF,** 10 minutes, 16mm, sound, black and white. Directs attention to the significant role which chemistry plays in our modern world. Traces the steps leading up to the production of electric furnace phosphorus. Portrayals of the work of research chemists and chemical engineers from the inception of the idea to the multiple uses of the completed product provide vocational information.

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• NATURE OF SOUND, Coronet, 10 minutes, 16mm, sound, black and white. As the railroad train roars across your movie screen, as a white puff rises from a distant factory whistle and its sound arrives seconds later, the nature of sound is simplified and clarified for your students. Our radio amateur will show them the picture of sound on his oscilloscope and leave them with a new, bright understanding of the principles of sound's vibration, its characteristics and transmission.

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Write to: Mr. Vernon L. Nickell, State Superintendent of Public Instruction, Springfield, Illinois.

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